2006 INTERIM REPORT FOR THE LIMERICK GENERATING STATION WATER SUPPLY MODIFICATION DEMONSTRATION PROJECT AND WADESVILLE MINE POOL WITHDRAWAL AND STREAMFLOW AUGMENTATION DEMONSTRATION PROJECT

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December 2006

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EXECUTIVE SUMMARY

This interim report presents the results for the fourth year, 2006, of the Wadesville Mine Pool Withdrawal and Streamflow Demonstration Project (Demonstration). During the Demonstration, water pumped from the Wadesville Mine Pool at Pottsville and water released from Still Creek Reservoir at Tamaqua augmented the flow of the Schuylkill River for use as consumptive cooling makeup water by Exelon's Limerick Generating Station (LGS) some 75 miles downriver near Pottstown. High river flows were experienced during much of the 2006 Demonstration period in sharp contrast to the lower flows during the 2005 Demonstration. As a consequence, very limited quantities of water were withdrawn from the Mine Pool and released from the Reservoir.

The Demonstration was governed by Docket Revision 12 which was approved by the Delaware River Basin Commission (DRBC) in October 2004. This Revision allows the Demonstration to extend through 2007, and possibly 2008, in order to monitor for potential environmental impact during more representative low-flow conditions and under modified water augmentation conditions than were experienced in 2003, the first year of the Demonstration.

The main objectives of the first two years of the Demonstration had been to show that water pumped from the Wadesville Mine Pool and released from Still Creek Reservoir (for non-emergency use) can provide a viable supply of water to the Schuylkill River for consumptive use by LGS, allow a corresponding reduction in the amount of water withdrawn from the Delaware River via the Point Pleasant Diversion, and have positive or insubstantial ecological effects. For 2005 and 2006 the Project sought to also demonstrate that withdrawal of limited quantities of unaugmented consumptive cooling makeup water from the Schuylkill River by LGS would not have a substantial effect on downstream dissolved oxygen (DO) when ambient river temperatures exceed 59^{o}F and river flows at the Pottstown Gage are above 560 CFS.

The fourth year of the Demonstration was conducted from April through October 2006 following an Operation and Monitoring Plan approved by the DRBC as part of Docket Revision 12. This Plan provides rules for conducting the Demonstration, including operational as well as environmental monitoring responsibilities. The environmental monitoring focused on water quality and aquatic biology.

Several watercourses conveyed water to LGS and were monitored during the Demonstration Project. East Norwegian/Norwegian Creek and the Schuylkill River conveyed Wadesville Mine Pool water. The East Branch Perkiomen Creek and Perkiomen Creek conveyed Delaware River water via the Point Pleasant Diversion Project, but at the reduced minimum flow volume implemented after the 2004 Demonstration. In addition, water from Still Creek Reservoir, located near Tamaqua, was conveyed to the Schuylkill River by way of Still Creek and the Little Schuylkill River. Monitoring was performed in the Schuylkill River downstream of LGS to determine if the water withdrawals at LGS would cause DO levels to be reduced to below the Pennsylvania Water Quality Standards.

The following is a summary list of the environmental monitoring that was conducted:

- Wadesville Pool water level, discharge rate and quality
- Schuylkill River flow and rainfall
- Lower Schuylkill River DO and other water quality measures
- Pottstown Water Treatment Plant and Pennsylvania American intake water quality

- East Norwegian Creek water quality
- Upper Schuylkill River biology and water quality
- Still Creek Reservoir discharge rate and water quality
- Little Schuylkill River biology, flow, and water quality
- East Branch Perkiomen Creek and Perkiomen Creek water quality

Water was pumped for LGS augmentation from the Wadesville Mine Pool into East Norwegian/Norwegian Creek on just 12 days during the period from May 30 through August 28 during which time the mine water surface level increased approximately 8 feet. Daily volume of water pumped ranged up to 9.15 million gallons per day (MGD), with most volumes in the range of 8 to 9 MGD. The total volume discharged for this year's Demonstration was 91.05 MG.

The mine water was sampled monthly for many water quality parameters, including constituents listed in the Mine's NPDES permit. All measurements were within the ranges expected based on the recent historical Wadesville Mine Pool data. Over the 4 years of the Demonstration, total dissolved solids (TDS) and pH varied within a similar range from year to year and, on average, have been fairly stable. Average values of specific conductance, manganese and sulfate have trended downward over the 4 years, while average values of iron and alkalinity have increased slightly from year to year.

Water quality results were as expected in East Norwegian Creek and in the Schuylkill River upstream and downstream of the confluence. Generally higher downstream measurements of total dissolved solids, specific conductance, total alkalinity, and pH and generally lower downstream concentrations of total and dissolved iron were observed in 2006, similar to the observations in 2003 to 2005.

Biological resources in the Schuylkill River upstream and downstream of the Norwegian Creek confluence were monitored during May and August. The fish communities at both locations contained a mixture of cool and warmwater species, with blacknose dace, creek chub, white sucker, and green sunfish most abundant. Small numbers of rainbow, brown, or brook trout were collected from both locations; most appeared to be wild fish, while others were apparently stocked. Low numbers of macroinvertebrate taxa were collected at both Schuylkill River locations, and more taxa and more individuals were present downstream than upstream in both months. The positive results in 2006, although with limited use of the Mine Pool, were similar to those reported for 2003 through 2005 and support the continued use of the Wadesville Mine Pool.

Dissolved oxygen concentrations were monitored at the LGS Intake, Vincent Pool, Black Rock Dam, and Norristown Pool from April through October and at the Pennsylvania American Intake, at Vincent Pool, from June through October. The data indicate that fluctuations in DO were not significantly related to changes in Schuylkill River discharge during periods of low flow (less than 860 CFS). River discharge remained below 860 CFS for 32 days during June and August and was less than 560 CFS average during 2 days.

Schuylkill River flow was also augmented by discharges from Still Creek Reservoir during the Demonstration. Total volume released was 223.6 MG from May through August which only caused a *de minimis* change in the Reservoir water surface elevation. The discharges from Still Creek appeared to have a small positive effect on the Little Schuylkill River.

The Bradshaw Reservoir pumped releases to the East Branch Perkiomen Creek maintained a minimum stream flow of approximately 10 CFS throughout the Demonstration. Monitoring performed in the East Branch and in Perkiomen Creek indicated no adverse impact due to reduced water flow from Bradshaw.

The fourth year of the Demonstration Project again showed that the Wadesville Mine Pool and Still Creek Reservoir are operationally reliable and environmentally suitable sources of consumptive cooling makeup water for LGS. Both augmentation sources were used sparingly in 2006 and this limits our ability to measure the effects of the augmentation water on various aspects of the biological community. However, the biological community has not changed over the 4 years of the Demonstration and this is important evidence that confirms the augmentation sources as environmentally sound. In addition, the expanded Demonstration showed that withdrawal from the Schuylkill River of a portion of the consumptive water needed by LGS without the restriction related to ambient river temperature did not affect downstream dissolved oxygen compliance with the Water Quality Standards. The results from 2006 support continued suspension of the temperature restriction during the next Demonstration monitoring period so that LGS can withdraw the full amount of consumptive water with no augmentation until river flows decrease to 560 CFS as provided for in Docket Revision 12 and again provide support for permanent suspension of the temperature restriction.

In 2006, the Demonstration Project resulted in a contribution of about $270,000 to the Restoration and Monitoring Fund. The Fund supports environmental restoration projects that target water quality improvements within the Schuylkill Basin.

Projects awarded with the 2005 Fund were:

- Berks County Conservancy--$50,931 for agricultural and stream bank improvements on two farm properties in the headwaters of the Maiden Creek watershed.
- Berks County Conservation District--$65,000 for improvements to a tributary of Irish Creek, in Centre Township, addressing non-point source of pollution concerns on a farm property.
- Perkiomen Watershed Conservancy--$20,175 for reconstruction and stabilization of a headwater tributary of the Unami Creek.

Based on the past 4 years of the Demonstration, the data supports:

- Permanent approval of augmentation from Wadesville Mine Pool,
- Permanent approval of augmentation from Still Creek Reservoir,
- Permanent removal of the 59° temperature limit, and
- Removal of the 4-day travel time provision.

1.0 INTRODUCTION

1.1 Overview of the Demonstration Project

In June 2003, Exelon Generation Company LLC (Exelon) received approval from the DRBC via Revision 11 to Docket D-69-210 CP (Final) to conduct a Demonstration Project involving supplementing the flow of the Schuylkill River by pumping water from the Wadesville Mine Pool into the headwaters of the Schuylkill River at Pottsville (Figure 1.1-1). The intent of the project was to augment the flow of the Schuylkill River during the yearly season associated with low river flow and when river temperatures exceed 59^{o}F, and thereby increase the time that LGS would be allowed to withdraw consumptive cooling water from the river. This increase in the use of the Schuylkill River for consumptive cooling use at LGS would allow a corresponding reduction in the amount of water diverted for the same purpose from the Delaware River into the East Branch Perkiomen Creek (EBPC) via the Point Pleasant Diversion Project.

A DRBC-approved Operating and Monitoring Plan was implemented to govern the conduct of the Demonstration and verify that use of the mine water or Still Creek Reservoir water would not cause unacceptable environmental impact. The Delaware River water diversion system was maintained in operation during the pumping Demonstration, in accordance with the requirements of the approved Operating Plan, so that it could provide the full amount of water required by LGS if necessary. In addition, the Docket revision allowed for releases from Tamaqua's Still Creek Reservoir (subject to its yield curve limitations) at any time rather than only during emergency conditions.

Initially, the Demonstration was scheduled to extend over only one (the 2003) pumping season. However, due primarily to abnormally high ambient streamflow conditions in the watershed which made it difficult, if not impossible, to definitively determine if environmental impacts would develop, the Demonstration was extended to a second (the 2004) pumping season in order to provide additional assurance that the predicted negligible environmental effects would occur from the use of the mine pool source. Again, abnormally high ambient flow conditions prevailed during the 2004 pumping season.

In mid-2004 Exelon applied to the DRBC for approval to extend and expand the Wadesville and Still Creek Demonstration Project by modifying Schuylkill River withdrawal restrictions related to ambient water temperature, instead relying on a Schuylkill River low flow threshold to trigger flow augmentation from the up-basin sources. In October 2004 the DRBC approved Revision 12 to the Docket which allowed the expanded Demonstration to continue through 2007 with an option to extend through 2008 to demonstrate, under controlled conditions, that withdrawal of Schuylkill River water would not cause adverse impact when ambient water temperatures exceed 59^{o}F, the maximum temperature at which unaugmented withdrawals were permitted under Docket Revision 11. In addition, the project intends to show that no adverse impacts will occur in the East Branch Perkiomen Creek due to replacing the minimum flow requirement of 27 cubic feet per second (CFS) after initiation of pumping at Bradshaw Reservoir with a 10 CFS requirement.

A significant feature of the Demonstration Project which was added in Revision 12 of the Docket is the creation of a Restoration and Monitoring Fund (RMF). Exelon will contribute to the RMF based on the quantities of consumptive cooling water that are not required to be augmented. The objective is to use the RMF to support restoration projects which can make a significant improvement in water quality within the Schuylkill River Basin.

Interim reports for each Demonstration period have been issued annually. The data and analyses for the fourth Demonstration period which extended from April to October 31, 2006 are contained in this report.

1.2 Basis for the Project

At full power operation, LGS's per unit consumptive cooling use rates are 17.5 million gallons per day (MGD) average and 21 MGD maximum. These are equivalent to approximately 24,300 gallons per minute (GPM) average and 29,200 GPM maximum for the two units at LGS. The anticipated maximum mine pool yield was approximately 9,000 to 10,000 GPM, which represents approximately 40 percent of the average consumptive cooling makeup requirement for LGS. The balance of the makeup requirement would be provided from Tamaqua's Still Creek Reservoir and the diversion system from the Delaware River. Exelon would operate the mine pool as an underground reservoir with pumping over an approximately 6-month period followed by 6 months of recharge. By using this plan, the pool would be managed as a renewable resource.

The primary drivers for identifying one or more additional sources of consumptive cooling makeup were to expand the source water options available to LGS (thus providing increased reliability and operational flexibility), obtain net environmental benefits to the Delaware River Basin, and reduce Exelon's costs associated with the operation and maintenance of the diversion system.

The project is compatible with Pennsylvania's policy to encourage the use of a mine water source for cooling water purposes in the generation of electricity and, as such, was actively supported by the Pennsylvania Department of Environmental Protection (PADEP). The policy is intended to address the problems associated with the release of acid mine drainage from abandoned, inactive, or underutilized coal mines, which has caused severe adverse effects on the water quality and beneficial uses of Pennsylvania's rivers and streams. This pollution limits the ability of the streams to support abundant aquatic life and recreational activities, and transforms a natural asset into a liability.

The process of searching for a viable water source within the Schuylkill River Basin began in 2002 and led to Wadesville being selected as the leading candidate. The search for alternate water sources found that only mine waters were capable of reliably supplying the sizeable quantities of water required. The Wadesville Mine Pool was the most advantageous source of augmentation water for the Demonstration Project in comparison to other sources considered. Among the reasons that Wadesville was selected were:

- Significant capital improvements were not required to commence pumping in 2003.
- The mine pool water is naturally high in alkalinity, which improves the buffering capacity of the receiving stream.
- The mining company (Reading Anthracite Company or RAC) was willing to commit resources and enter into a binding contract for providing the service of water pumping.
- The discharge had an approved NPDES permit and met its conditions.

2.0 DESCRIPTION OF THE WADESVILLE MINE SITE

2.1 Project Setting

The productive coal areas in the anthracite region of Pennsylvania are in four distinct fields: Northern, Eastern Middle, Western Middle and Southern. The Southern anthracite field, in which the Wadesville Mine is situated, has an area of about 200 square miles, extending about 70 miles in the east-west direction and 1 to 6 miles wide in Carbon, Schuylkill, Dauphin, and Lebanon Counties from Jim Thorpe and the Lehigh River on the east to the Susquehanna River on the west. The Wadesville mining operation is in the Beechwood-Wadesville-Pine Forest Basin of the Southern Middle Anthracite Field in Schuylkill County (near Pottsville), Pennsylvania, and geologically, in the Llewellyn Formation.

The anthracite region has a long history of extensive deep shaft mining since the early 1800s and surface (strip) mining since the 1940s. These past and ongoing mining operations allow surface water to enter the mine workings and accumulate. The water is impounded in underground pools and in abandoned stripping excavations. Barrier pillars separate the mine pools from each other. The impounded water has to be pumped to the surface or overflows by gravity through drainage tunnels or breaches upon reaching an elevation that varies from pool to pool. There are approximately 31 major underground pools in the Southern field, including Wadesville, plus a larger number of surface pools from stripping operations.

2.2 Wadesville Mine Pool Water Quality

Mining operations allow moisture and air to come into contact with sulfur-bearing minerals (iron sulfides, pyrite, and marcasite) that naturally occur in this region. As a result, chemical reactions take place which lead to the formation of sulfuric acid. Most of the water in the deep mine pools becomes highly acidic and, if allowed to drain into surface waters, the acid mine drainage or AMD becomes an appreciable source of stream pollution. The water in the Wadesville Mine Pool is an exception in that it has a pH in the neutral range (typically 6 to 8) and a moderate level of alkalinity. These characteristics made this source of augmentation water much superior in comparison to several other candidate mine pool sources.

Historically prior to the Demonstration, the acidity levels of the Pool water were negligible [<1 milligram per liter (mg/l)] and the alkalinity levels were on the order of 300-400 mg/l. Specific conductance levels ranged about 1,500-1,800 micromhos per centimeter (µmhos/cm), sulfate 500-700 mg/l, and water temperatures 55-60°F.

2.3 Wadesville Mine Works History

The deep mine operation at the Wadesville Colliery was discontinued in 1930, and with the cessation of pumping, the water pool within the mine increased to such a high level that the overflow discharged into Mill Creek at Saint Clair from an abandoned Saint Clair Colliery shaft. In 1949, the now RAC started stripping operations for recovery of coal and installed deep well pump equipment to discharge excess mine water into the Schuylkill River via Norwegian Creek. RAC has continued stripping operations with several interruptions up to the present time period. RAC's future plans to continue mining at Wadesville are not clearly defined. However, without continued pumping, the mine pool elevation would increase until it overflows into Mill Creek.

The potential for this overflow is of concern because of development that has occurred in Saint Clair in the vicinity of the overflow site since the last period of overflow.

2.4 Mine Dewatering Facilities

The existing pump house, which is located at the Wadesville vertical borehole shaft approximately ¼-mile from the open pit, contains pumping equipment used for dewatering of the mine to support present-day surface mining operations. The top of the shaft is at elevation (El) 782 feet above Mean Sea Level (MSL) and the current elevation of the bottom of the pool is at approximately 85 feet MSL. The overflow elevation through an existing pipe at the abandoned Saint Clair shaft is at El 732 feet MSL. A federal government agency estimate of the water volume in the workings in 1953 was 3.4 billion gallons.

Two vertical turbine pumps are installed in the Wadesville mineshaft. Together they have a maximum design discharge rate in the range of 9,000 to 10,000 GPM. Note that the design pumping rates may have increased because both pumps had major overhauls since the Demonstration began. Prior to the Demonstration, the pumps operated periodically to maintain the water level at approximately 450 feet (El 332 feet MSL) below the surface to support active strip mining. In the first pumping season the bottoms of the pumps were approximately 500 feet (El 282 feet MSL) below the surface. During 2004 one of the pumps was refurbished and lowered to 600 feet (El 182 feet MSL) below the surface to gain access to additional pool volume. In 2005, both pumps were used as needed until the water level dropped below approximately 500 feet, at which time the pump withdrawing from the 500-foot level shut down. Note that the pump at the 500-foot level developed operating difficulties during the 2005 pumping season and can not be used until it is repaired. In September 2006 the deep pump became inoperable and will be repaired prior to the 2007 Demonstration period.

The discharge path from the pump house to the Schuylkill River is initially open-channel flow via a dry swale and then to what is locally known as East Norwegian Creek until it reaches the northern end of Pottsville. At this point, a subsurface conduit channels the flow through Pottsville until it daylights on the southern end and immediately discharges to the Schuylkill River.

3.0 THE DEMONSTRATION PROJECT

3.1 Operation Plan

Part I of the DRBC-approved Demonstration Operation and Monitoring Plan which was included as Attachment 3 to Docket Revision 12, provides rules for continuing the Demonstration of stream flow augmentation by Wadesville Pool and Still Creek Reservoir and for increased withdrawals from the Schuylkill River for some or all of the consumptive cooling makeup at LGS after the 59°F temperature restriction is reached, as long as the Schuylkill River flow at Pottstown is higher than a daily average of 560 CFS (or 530 CFS if only one LGS unit is operating). It identifies the plan of operation; responsibilities of Exelon, RAC, and DRBC during the Demonstration Project; and specifies the pumping equipment configuration, evaluation criteria, and reporting requirements. In addition, it describes the restoration and monitoring fund that LGS has established to fund projects designed to improve water quality within the Schuylkill River Basin.

3.2 Monitoring Plan

Part II of the Plan specifies the parameters to be monitored, the methodologies, the frequency, and locations to be sampled in order to provide the data necessary to assess the impacts of the mine water and reservoir releases on Norwegian Creek and the Schuylkill River, the increased consumptive withdrawals from the Schuylkill River at LGS, and the decreased diversion flows to East Branch Perkiomen Creek. In short, the monitoring plan was designed to measure water quality and aquatic biological impacts to these waters.

3.3 Affected Surface Waters

Several watercourses conveyed water to LGS during the Demonstration Project. These include East Norwegian/Norwegian Creek, tributary to the Schuylkill River at Pottsville, and the main stem Schuylkill River. Other surface waters were affected by the Demonstration Project as well. Water from Still Creek Reservoir, a public water supply operated by the Tamaqua Water Authority, was discharged via Still Creek to the Little Schuylkill River, which joins the Schuylkill River at Port Clinton some 15 miles downriver of Pottsville. The East Branch Perkiomen Creek and Perkiomen Creek, components of the Point Pleasant Diversion Project, received reduced amounts of water from Bradshaw Reservoir.

Wadesville Mine Pool water was discharged to a swale that ordinarily would be dry, except when it conveys surface runoff in wet periods. The swale connects to East Norwegian Creek, which mostly flows within a constructed channel to the north part of Pottsville where it enters a long underground conduit. Within this conduit, East Norwegian Creek joins with West Norwegian Creek to form Norwegian Creek, which flows through the conduit to the Schuylkill River in Pottsville (Figure 4.5-1). LGS withdraws cooling water from the Schuylkill River approximately 75 miles downriver of Pottsville.

The East Branch Perkiomen Creek receives water from the Point Pleasant Pumping Station on the Delaware River via the intermediate Bradshaw Reservoir. This water is discharged via pipeline to the headwaters of East Branch and then flows to the Perkiomen Creek. From here, the water continues downstream to the Perkiomen Pumping Station at Graterford for conveyance by pipeline to LGS or, if only the minimum flow of approximately 10 CFS is being released, it is allowed to continue flowing down the Perkiomen Creek to the Schuylkill River. This system for supply of make-up water to LGS is known as the Point Pleasant Diversion Project.

4.0 MONITORING PROGRAM AND RESULTS

During operation of the Demonstration Project, the following data collection and monitoring was conducted in order to assess potential environmental impacts:

- Wadesville Pool water level, discharge rate, and quality
- Schuylkill River flow and rainfall
- Lower Schuylkill River dissolved oxygen (DO) and other water quality measures
- Pottstown Water Treatment Plant and Pennsylvania American intake water quality
- East Norwegian Creek water quality
- Upper Schuylkill River biology and water quality
- Still Creek Reservoir discharge rate and water quality
- Little Schuylkill River biology, flow rates, and water quality
- East Branch Perkiomen Creek and Perkiomen Creek water quality

These programs encompassed measurement of a wide range of parameters at differing frequencies. A description of each program element and results obtained during the Demonstration Project follow.

4.1 Wadesville Pool Water Level, Discharge Rate and Quality

Pumping of Wadesville Mine Pool water into East Norwegian Creek for augmentation occurred for three short periods between May 31 and August 27. The daily total volume of water pumped and the resulting change in mine pool water level were measured. In addition, measurements of conductivity were made in the pump discharge flow at the pumphouse. Daily measurements of temperature, pH, and DO were not required or recorded in 2005 and 2006 since these parameters varied within a narrow range in 2003 and 2004 and were no longer of concern.

During the entire 2006 Demonstration, mine pool water augmentation was credited on only 12 days (Table 4.1-1). Pumping occurred during short intervals in late-May, mid-June and late-August. The daily total volume of water pumped from the mine pool for LGS use ranged up to 9.15 million gallons per day (MGD) and totaled 91.05 million gallons (MG) through the end of the pumping period (Table 4.1-1 and Figure 4.1-1). Most daily volumes pumped were in the range of 8 to 9 MGD. These short pumping intervals for river augmentation had little impact on lowering pool levels. The mine company pumped as required to maintain pool levels below their mining operations. The figure shows the overall mine pool levels for the Demonstration period and the pumping amounts for augmentation (Table 4.1-1 and Figure 4.1-1).

Specific conductance varied from 695 to 1,396 µmhos/cm and was stable or trended downward during each of the short pumping periods (Table 4.1-1 and Figure 4.1-2). This trend is similar to those trends seen in previous years during which specific conductance decreased during the initial periods of pumping. Mean conductivity was lower than in previous years but this result is not conclusive due to the limited mine water pumping during the Demonstration period. In previous years, conductivity trended upward slightly at the end of the season likely due to the pumping of mine pool areas not tapped for long periods.

Several other water quality parameters were determined monthly and included those required by the mine's NPDES permit plus total organic carbon (TOC), TDS, DO, pH, specific conductance and temperature. Water samples were collected from the pump discharge for analysis.

In general, Wadesville Pool water was neutral in pH with low acidity and relatively high alkalinity (Tables 4.1-2 and 4.1-3). Except for iron, measurements of the parameters commonly associated with mine water (iron, manganese, and sulfate) were within the expected historical range[1].

Over the 4 years of the Demonstration, TDS and pH varied within a similar range from year to year and on average have been fairly stable (Tables 4.1-2 and 4.1-3). Average values of specific conductance and manganese have continued to trend downward over the 4 years, while average values of iron and have increased slightly from year to year. Mean total iron increased from the previous year and the maximum value of 6.95 was above the range of values previously measured but well below the 10 mg/l limit.

4.2 Schuylkill River Discharge and Local Rainfall

Schuylkill River discharge is measured by the U.S. Geological Survey (USGS) at Landingville, Berne, Reading, and Pottstown. These gages are located between the Norwegian Creek confluence and LGS. In addition, rainfall is measured at the Landingville gage. Data for these locations are presented in Table 4.2-1.

Hydrographs for the Schuylkill River at Landingville (downstream gage located nearest to the Norwegian Creek confluence) and at Pottstown (Figure 4.2-1) show that the 2006 Demonstration was characterized by above average river discharge except for two short periods of lower discharge in late-June and late-August. Mean monthly Schuylkill River flow at Pottstown in 2006 was higher than the period of record for June through October and about half of the mean discharge for the period of record in April and May (Table 4.2-2). Note that discharge at Pottstown was well above the critical flow (560 cfs) for most of the Demonstration except for two short periods in June and August. Similarly, at Landingville, discharge was higher than the period of record for June, July, September, and October, approximately equal to the period of record in August and roughly half of the discharge for the period of record in April and May.

Overall, Schuylkill River basin hydrology in 2006 could be characterized as being non-typical with a dry spring and extremely wet summer. The wet summer included a near-record flood in late-June that elevated river flows for several weeks. This pattern is similar to 2003 and 2004 in which uncharacteristically high river discharge was recorded for July through October and in direct contrast to the low flow year of 2005.

Rainfall at Landingville during the 2006 Demonstration period was 41.07 inches. This is approximately double the amount of rainfall recorded in 2005 (21.8 inches) and essentially equal to rainfall amounts recorded during 2004 (40.3 inches).

[1] Note that when a discharge from an area disturbed by mining activity without chemical or biological treatment has a pH greater than 6.0 and a total iron concentration of less than 10.0 mg/l, as is the case with Wadesville, the PADEP manganese limitations (2.0 mg/l 30-day average and 4.0 mg/l daily maximum) do not apply [ref. 25 PA Code §88.9(c)(2)].

4.3 Lower Schuylkill River Water Quality

DO, temperature, and pH were monitored hourly using Hydrolab Minisonde 4A instruments at four locations on the lower Schuylkill River: in front of the LGS cooling water intake, at the Pennsylvania American Water Company intake, at Black Rock Dam, and in the Norristown Pool (Figure 4.3-1). At the LGS intake, the instrument was suspended just below the water surface from a floating dock located just in front of the intake structure. The monitor in Black Rock Pool was installed within a perforated pipe enclosure affixed to the Dam so that the monitor sampled the water about to flow over the dam. At the Pennsylvania American Water Company intake, the Hydrolab was installed inside a perforated pipe enclosure that was mounted to the upstream side of the intake structure. In Norristown Pool, the monitor was installed in a similar enclosure mounted to a support structure on the Norristown (Montgomery County) side of the road bridge leading to Barbados Island. Monitoring began on April 1 at LGS, Norristown, and Black Rock and on June 10 at the Pennsylvania American intake. Monitoring continued to October 31 at LGS, Black Rock, Pennsylvania American, and Norristown Pool. The Black Rock Pool recorder was removed on June 24, prior to the flood, and was not reinstalled until August 9 because the mounting structure had been destroyed by the flood.

In addition, DO data are available from the USGS for a monitoring station in the pool formed by the partially breached Vincent Dam near Linfield below LGS (Figure 4.3-1). Data from this site are presented for the period from April 1 to June 25. On June 29 a large flooding event destroyed the USGS monitoring equipment and data were unavailable after this date.

DO concentrations generally followed the same trend at each of the five stations throughout the Demonstration period (Figures 4.3-2 through 4.3-8, Table 4.3-1). In general, the lowest monthly mean DO concentrations were recorded in August and the lowest instantaneous minimum DO values were recorded in June for Norristown and Black Rock pool stations and in August for the Limerick and Pennsylvania American stations. During the Demonstration period, DO concentrations usually cycled over 24-hour (diel) periods with the highest concentrations found during the late afternoon to early evening hours and lowest concentrations during the early morning hours (Figure 4.3-9). This diel oscillation in DO concentrations is typical of rivers and is primarily due to aquatic vegetation photosynthesis in excess of aquatic organism respiration during daylight and continued respiration with no photosynthesis during the night. Disruptions to the normal diel cycle usually were related to rainfall events and the resulting rise in river flow.

Regression analyses were performed to determine the relation of daily mean DO to daily mean discharge on days when river discharge was less than 860 CFS. For all monitoring stations, daily mean DO was not significantly correlated to river discharge less than 860 CFS. The lowest mean daily DO value (5.15 mg/l) for all stations was recorded at Norristown Pool on June 1 and is above the minimum value (5.00 mg/l) established as a trigger level for the Demonstration. The lowest mean monthly DO concentration (6.29 mg/l) was recorded at Black Rock pool in June. The lowest instantaneous DO concentration (3.55 mg/l) was recorded at Norristown Pool in June (Table 4.3-1) and was below the minimum instantaneous water quality standard of 4.0 mg/l. The lowest instantaneous reading was taken at 5:00 am on June 2 and was coincident with a considerable increase in water temperature (Figure 4.3-8). The low instantaneous reading occurred briefly at the bottom of the diel oscillation. The low value was not related to any changes in water supplies or in consumptive water use by LGS. Based on all four monitoring station data, there appeared to be a river wide effect causing a depression in DO for about three or four days which was magnified by increasing water temperatures.

Three DO concentration anomalies occurred in early-June (discussed above), mid-June and early-August (Figures 4.3-4 through 4.3-8). These anomalies were abnormal in that the DO concentration decreases did not follow previous trends related to the cycling of DO. The DO concentrations at all stations decreased substantially during this time (approximately 1mg/l) and then quickly rebounded within a few days. These events were investigated by the DRBC and their investigation included a tour of the river and a visit to each of the DO monitoring stations. Because the DO values for all stations were similarly affected, it is reasonable to conclude that these anomalies were caused by events that occurred upstream of the Limerick Intake. In no way was this DO depression related to activities at LGS or to the Demonstration project. It does not seem plausible that this type of change in DO would be caused only by natural processes within the river. Possible explanations that we could offer for the decrease in DO would be purely speculative.

For two short periods during June and August augmentation water was necessary for use by LGS. Augmentation water was released from Still Creek Reservoir and pumped from the Wadesville Mine Pool to supplement Schuylkill River flows. During the first event, water was pumped from the Mine Pool from June 19 to June 23 and released from Still Creek Reservoir from June 15 to June 23. Likewise, during the second event water was pumped from the Mine Pool from August 23 to August 27 and water was released from Still Creek Reservoir from August 24 to August 27. To better evaluate the effects of the augmentation water, two stations (Limerick intake and Norristown Pool), were selected for additional analysis. Figures 4.3-10 through 4.3-13 illustrate the relation of DO and river discharge before, during, and after augmentation for these two periods.

For both periods, mean daily DO concentrations were well above the established trigger level for the Demonstration. Mean daily DO concentrations at Limerick intake during these intervals was 7.95 in June and 7.25 in August and at Norristown Pool mean DO was 6.42 in June and 6.73 in August. For both stations, the several days following the initial make-up water release did not show much of a change in DO. Interestingly, a potential positive effect of augmentation (increased DO) might be expected, not a decrease in DO concentrations (Figures 4.3-10 and 4.3-11). The few observed trends during these periods cannot be related to the release of augmentation water due to other confounding factors. During both augmentation periods the potential effects of the supplemental water were masked by rainfall and a subsequent increase in river flow.

In general, mean pH over the Demonstration period was similar for all four stations with lowest mean (7.00) and instantaneous minimum (6.47) values recorded from Norristown Pool during June. The highest instantaneous maximum (9.37) pH was recorded from the Limerick Intake in April (Table 4.3-2). The largest recorded variation in daily pH measures was 1.57 at the Pennsylvania American station on July 18 (Figure 4.3-5). This diel variation in pH was observed at all stations, as expected, coincident with the cycling of DO (Figure 4.3-4 - 4.3-8). Photosynthesis by aquatic plants removes carbon dioxide from water during daylight, thus causing a rise in pH. Then, during the night, aquatic plant respiration produces carbon dioxide which decreases the pH.

Temperatures for all of the stations were similar with the maximum values recorded in the two pool stations (Table 4.3-3). The highest temperatures for Limerick, Black Rock, and Norristown were recorded on August 3 and for Pennsylvania American on June 2. The greatest daily fluctuation in temperature for all of the stations was recorded on June 1 at Limerick (11.7 °F)

(Figure 4.3-4). The largest daily range for Black Rock and Norristown was recorded on June 2 and for Pennsylvania American on July 18 (Figures 4.3-5 - 4.3-8).

4.4 Lower Schuylkill River Water Treatment Facilities

Pottstown Water Treatment Plant

The Borough of Pottstown's Water Treatment Plant is the first drinking water intake on the Schuylkill downstream of Pottsville and, therefore, the first intake potentially affected by water pumped from the Wadesville Mine Pool. Pottstown routinely measures the pH and specific conductance of the raw water withdrawn from the Schuylkill River. We utilized their data to supplement our own data collection efforts. The pH of the intake water is recorded at 2-hour intervals each day. The observed daily ranges are shown in Table 4.4-1. During the Demonstration, intake water pH ranged from 6.9 to 8.7 standard units. Although the daily range on most dates was 0.2 standard units or less, the greatest range observed was 1.7 standard units on April 17, prior to initiation of Wadesville Mine Pool pumping. This occurred during a period of low and stable river flows which appeared to coincide with the onset of intense photosynthesis with its wide swings in DO and pH as shown by the data obtained simultaneously at the previously discussed water quality stations (Figures 4.3-4 through 4.3-8).

The daily measurements of specific conductance ranged from 300 to 540 µmhos/cm, with most readings in the 400s. This parameter was not correlated with river discharge. This result is in sharp contrast to the 2005 Demonstration results when conductivity, measured at the Pottstown water treatment plant, was strongly correlated with river discharge. The difference in this relation between years is a result of the low flows that prevailed during much of the 2005 Demonstration in contrast to the higher flows during the 2006 Demonstration. However, the highest conductivity measurement was recorded during late-August when river flows were at the lowest recorded values during the 2006 Demonstration period. Overall, conductivity and pH values measured during the 2006 Demonstration were within the same range as in the 2005 Demonstration.

Sampling of additional parameters, i.e., TDS, iron, manganese, total organic carbon (TOC), and sulfides was scheduled to take place at the Pottstown water intake when river flows at the USGS Pottstown gage decreased below 560 CFS for four consecutive days. The purpose of this sampling was to assure that Borough personnel were informed about water quality trends that could result in increased treatment costs or potentially cause a violation of the drinking water quality limits applicable to the finished water. However, daily average Schuylkill River flows did not fall below the trigger level for four consecutive days during the 2006 Demonstration.

Pennsylvania American Water Company

The Pennsylvania American water intake on the Schuylkill River near Linfield (below LGS but upstream of the Vincent Pool USGS monitoring site) was sampled for TDS on seven occasions from April 29 to October 31. Monthly sampling was to be completed unless river flows at Pottstown were below 560 CFS, then weekly sampling was to be performed. River flows during 2006 did not reach levels that required weekly monitoring.

Monthly measures of TDS ranged from 118 to 350 mg/l with all values being below the threshold limit for finished drinking water. TDS was negatively correlated with river discharge (Figure 4.4-1). This relation is similar to what was observed during the 2005 Demonstration. In addition, DO, specific conductance, pH, and temperature were also determined (Table 4.4-2).

4.5 East Norwegian Creek and Upper Schuylkill River Water Quality

Water quality sampling was conducted at single locations in East Norwegian Creek and in the Schuylkill River upstream and downstream of the confluence, coincident with Schuylkill River biological monitoring (Figure 4.5-1). The East Norwegian Creek station is located near Coal Street in Pottsville, immediately upstream of the long culvert which conveys the stream underground through Pottsville. Schuylkill River Station 106 is located approximately 0.5 miles upstream of the mouth of Norwegian Creek, Station 107 is between Station 106 and the mouth of Norwegian Creek, while Station 109 is located approximately 3 miles downstream of the confluence. For the upstream stations, temperature data was recorded at Station 107 and water quality data was collected at Station 106. At Station 109 (downstream) both water quality and temperature data were collected.

Based on our data, mixing Norwegian Creek water with the Schuylkill River seemed to have a small positive effect downstream of the confluence (Table 4.5-1). In general, total dissolved solids, specific conductance, total alkalinity, and pH were higher downstream. These same relationships were observed during the previous years of the Demonstration. Norwegian Creek water adds buffering capacity to the river (higher total alkalinity) and has a higher pH. This addition of water acts to improve the water quality in the Schuylkill River that has been heavily degraded by a legacy of mining within the region.

Daily water temperature measurements were recorded using Onset StowAway temperature loggers in East Norwegian Creek and at Schuylkill River Station 107 and 109. The monitoring stations are the identical locations that were monitored for ambient river temperature in prior years of the Demonstration. Temperatures for all three stations were recorded from April to October.

As expected, the East Norwegian Creek discharge had a slight cooling effect on the Schuylkill River, but this effect did not persist very far downstream. Daily mean temperatures in East Norwegian Creek (47-65 °F) were regularly lower than the Schuylkill River at Stations 107 (45-67 °F) and 109 (46-68 °F) (Figure 4.5-2). The water temperature at Station 109, approximately 3 miles downstream of the Norwegian Creek confluence, was generally the warmest.

4.6 Upper Schuylkill River Biological Monitoring

Schuylkill River biological monitoring began on May 31, the first day that Wadesville Pool pumping was initiated, and was repeated on August 25. On both dates, active pumping from the mine pool was occurring. Sampling after the completion of pumping was not performed due to high Schuylkill River flows which prohibited scheduled sampling during the fall. The biological monitoring consisted of sampling fish and benthic macroinvertebrates (aquatic insects and other organisms that live on or in the river bottom) at indicator stations in the Schuylkill River upstream (Station 106) and downstream (Station 109) of the Norwegian Creek confluence (Figure 4.5-1). Stations 106 and 109 are part of the array of Schuylkill River locations previously sampled by the Pennsylvania Fish and Boat Commission.

Visual changes to river habitat at both stations were evident on the August 25 collection. These habitat changes were a result of the near-record flood that occurred in late-June. At Station 109, large amounts of sediment and cobble had been transported and deposited. A fairly deep run within the sample reach had been scoured and was difficult to effectively electrofish. Likewise, at station 106, large amounts of sediment (1-2 feet deep) had been deposited in several pools within the sample reach.

Consistent methods were used in the biological monitoring in order to aid in evaluation of the data. Fish were captured by electrofishing, with two tow boats, in approximately equal lengths of river at both stations. Captured fish were identified, counted, measured for total length, and released live to the river. Benthic macroinvertebrates were collected during single 15-second kick samples in two fast water velocity riffles and two slower water velocity riffle/runs using a D-frame kicknet (500µm). The kick samples for each station were combined and were preserved with isopropanol for transport to the laboratory where all macroinvertebrates were sorted from sample residue, identified, and counted. Both the fish and benthic macroinvertebrate sampling methods are standard procedures in aquatic biological investigations and were used in the previous Demonstration periods.

Similar fish species composition was present at both stations (Table 4.6-1). A total of 10 species were collected at Station 106 while 15 species were collected at Station 109. Excluding hatchery-reared trout, the most common species were blacknose dace, creek chub, white sucker, and green sunfish. Roughly equal numbers of individuals were captured at both locations. Note that the August 25 sampling at Station 109 had less effort than in past sampling events as a result of a generator malfunction that reduced sampling effort to only one electrofishing tow boat. This reduction in effort explains the few total number of fish collected (n = 393) on August 25.

Rainbow, brown, or brook trout were captured at both stations on each sampling date, but salmonids were only a small proportion of the total fish collected (excluding the stocked fingerlings). A fairly large number of stocked fingerlings were collected from Station 109 during the May 31 collection. Greater numbers of salmonids were found at Station 109 than Station 106.

The results for 2006 are similar to what was observed in previous years and indicate little effect of the Norwegian Creek discharge (Tables 4.6-2 and 4.6-3). There was little difference in species composition and in which species were most abundant between the stations or among years. Station 109 richness ranged from 12 to 14 taxa and station 106 richness ranged from 9 to 12 taxa. Furthermore, relatively similar total numbers of fish, including trout, were captured at both stations during all sample years.

Overall, more taxa and greater total numbers of macroinvertebrates were collected downstream than upstream of the Norwegian Creek confluence (Table 4.6-4). Total number of taxa collected during 2006 was higher at station 109 (n = 25) than at station 106 (n = 18). Similarly, total numbers of macroinvertebrates collected was higher at station 109 (n = 2,261) than station 106 (n = 1,265).

In general, totals of 18 and 25 macroinvertebrate taxa can be considered low compared to other streams within the region not impaired by acid mine drainage. Of the insect taxa considered intolerant of environmental disturbance, few mayflies (Ephemeroptera) and no stoneflies (Plecoptera) were collected at either station. However, of the mayflies collected, two mayfly genera were collected downstream and one mayfly genus was collected upstream of the East Norwegian Creek confluence. Three caddisfly (Trichoptera) taxa, also considered disturbance-intolerant, were collected at the two stations, with greater numbers of individuals collected downstream of the Norwegian Creek confluence.

Other macroinvertebrate taxa present at one or both stations included such crustaceans as crayfish (Decapoda), scuds (Amphipoda), sowbugs (Isopoda), and worms (Oligochaeta), in addition to several more insect groups. Most noteworthy among the insects, other than the intolerant groups discussed above, were the midges (Chironomidae). Midges were the dominant taxon among all sample dates for both stations. The midges are composed of many species, are widespread in distribution, and their presence in relatively large numbers is not unusual.

Macroinvertebrate abundance and richness has also been fairly constant for each station over the past 4 years (Table 4.6-5 and 4.6-6). For station 106, species richness ranged from 19 to 25 taxa and relative abundance was similar. Likewise, for station 109 species richness ranged from 22 to 27 taxa and relative abundance was similar. For both stations and for all years the most abundant macroinvertebrate was the chironomid. Dominance by one taxon is indicative of a stressed macroinvertebrate community and this is clearly evident for this section of the Schuylkill River.

Overall, pumping water from the Wadesville Mine Pool appears to benefit the macroinvertebrate community, noting that more macroinvertebrate taxa and individuals were collected downstream than upstream. This enhanced macroinvertebrate community translates to a more abundant food resource for fish.

4.7 Still Creek Reservoir Discharge Rate and Water Quality

Discharges from Still Creek Reservoir were used to augment Schuylkill River water volume, not for water quality enhancement or TDS management. During the Demonstration, water was released to augment Schuylkill River flows on only 19 days during early-May, mid-June, and late-August. Daily discharge reached a maximum of approximately 30.6 MGD and totaled 223.6 MG for the 2006 Demonstration period (Table 4.7-1). The reservoir water surface elevation was at or near the maximum elevation throughout the entire Demonstration period. In contrast, the reservoir water elevation was lowered over 7 feet and a total of 920.6 MG was released to augment Schuylkill River volume during the 2005 Demonstration.

Measurements of DO in Still Creek below the reservoir were made weekly when releases were occurring and ranged from 9.1 to 11.9 mg/l. The range of DO concentrations was similar to the values recorded during the previous Demonstration studies.

4.8 Little Schuylkill River Water Quality and Discharge

Water quality sampling was conducted at three locations within the upper Little Schuylkill River watershed, upstream of Tamaqua, on a monthly basis when releases were being made from Still Creek Reservoir. The sampling stations were located in the Little Schuylkill River upstream of the Still Creek confluence and below the SR 1020 bridge, in Still Creek near the PA Route 309 bridge (about 0.4 mile below Still Creek Reservoir), and in the Little Schuylkill River near the PA Route 54 bridge downstream of Still Creek and just above the confluence with Pine Creek (Figure 4.8-1). These locations were selected to determine the influence of Still Creek Reservoir releases on the Little Schuylkill River which has very poor water quality due to acid mine drainage above the Still Creek confluence. Water samples were collected for lab analysis of TDS and total alkalinity; field determinations of DO, specific conductance, temperature, and pH were performed at the time of sampling.

Onset temperature loggers were installed at the same locations where water quality sampling was conducted and an additional logger was placed at a downstream location in the Little Schuylkill River about 1.3 miles north of Tamaqua. Field determinations of DO, specific conductance, temperature, and pH were performed and aquatic habitat observations were recorded at each of the four stations when the temperature recorders were downloaded monthly.

For all of the sampling dates pH and total alkalinity in the Little Schuylkill River were higher downstream of the Still Creek confluence than above (Table 4.8-1). Likewise, DO, TDS, and specific conductance were lower for all of the sampling dates downstream of Still Creek. The Still Creek reservoir discharge has a positive effect on the chemical quality of the water in relation to it's suitability for aquatic life. The Still Creek discharge dilutes the acid mine drainage that contributes a majority of the stream flow to the LSR. These relationships are similar to those observed during the previous years of the Demonstration.

Water temperatures at the two Little Schuylkill River stations downstream of Still Creek and in Still Creek were warmer than in the Little Schuylkill River upstream of Still Creek (Figure 4.8-2). For the study period, mean temperatures were 62°F in Still Creek, 54°F in the Little Schuylkill upstream, 59°F in the LSR downstream, and 60°F in the LSR at Tamaqua. The warmest temperatures at all four stations were recorded in mid- to late-July. The upper Little Schuylkill River station was on average 5°F cooler than the other three stations and had the smallest variation in temperature throughout the study period. Flow at this location appeared to be dominated by mine drainage. The higher temperatures and wider range of temperatures at the lower sites appears to reflect natural warming that takes place as rivers flow downstream. An added influenced was the warmer water released from Still Creek Reservoir during July.

Water quality measurements taken during temperature logger downloads followed the same trends as described previously (Table 4.8-1). Aquatic habitat observations indicated limited changes among the four stations during the Demonstration period (Table 4.8-2).

During the 2006 Demonstration MinTroll pressure recorders were placed in the Little Schuylkill River both upstream (75 ft) and downstream (200 ft) of Still Creek and in Still Creek just upstream (150 ft) of the confluence with the Little Schuylkill River (Figure 4.8-3). The recorder was used to measure pressure hourly at each location. Pressure was then converted to water depth (feet) above the pressure recorder. Pressure measurements were recorded throughout the data collection period and manual stream discharge estimates were determined on six separate days for a range of flows in order to generate a rating curve to convert pressure readings to stream flow. A simple regression model was used to develop a straight line equation that was then used to estimate stream discharge at a given pressure.

LSR discharge was recorded from April to June and Still Creek discharge was recorded from April to October. Additionally, stream discharge is recorded by the USGS near Tamaqua several miles downstream of the aforementioned stations. As a result of the severe flooding that occurred in late-June the pressure recorders in the LSR were lost and some or all of the pressure measurements were lost. No data were obtained before the LSR upstream recorder was lost. Data were retrieved for April until mid-June from the downstream recorder before it was lost. The Still Creek recorder survived the flood thus stream discharge was estimated for this station from April to October. Water depth values outside the range of values used to develop the regression equation (e.g. low flow periods) were not used to determine discharge, thus discharge was not calculated for all days during the Demonstration. Still Creek mean discharge was estimated to be 14 cfs almost 30% higher than the same period in 2005. During the same time period LSR mean discharge at the USGS gage was 119 cfs. On the few days that releases occurred, we estimate that Still Creek Reservoir discharge contributed 25-70% of the total flow of the Little Schuylkill. Estimated daily discharge for the two stations and the USGS station daily discharge followed a similar trend throughout the Demonstration period (Figure 4.8-4).

4.9 Little Schuylkill River Biological Monitoring

Fish communities were surveyed at two different locations downstream of the Still Creek confluence with the Little Schuylkill River in May and August**.** The fall sampling was not performed due to persistently high flows. The most upstream site was near the Tamaqua water plant with the downstream boundary being a few hundred meters downstream of the confluence with Still Creek. The second site was farther downstream and started approximately 200 meters upstream of the Pine Creek confluence (Figure 4.9-1). Sampling in previous years determined that no fish were present upstream of the Still Creek confluence in the LSR, thus no additional sampling was performed upstream of Still Creek. An electrofishing tow boat that produced DC current was used to complete the fish surveys. Captured fish were identified, measured for length, enumerated and released. In addition, water temperature, DO, pH, and specific conductance were recorded during sampling (Table 4.9-1).

Few fish were captured at the most upstream station (Table 4.9-1). Of these, brook trout was the only species that would be considered a resident stream species. The yellow perch and brown bullhead were most likely washed out of Still Creek reservoir during the late-June flood. At the downstream station, more species and greater numbers of fish were collected. Brook trout was the most abundant species, similar to the community structure observed during previous years of sampling. Similar to the upstream station, the yellow perch captured downstream was most likely washed from the reservoir during the flood. The greater number of brook trout at the downstream station can be attributed to the higher water pH downstream than upstream. During all sampling visits to these stations (2005-2006), the pH was higher downstream. The higher pH downstream resulted from Niefert Creek and other smaller tributaries which contribute higher pH water to the LSR.

4.10 East Branch Perkiomen Creek and Perkiomen Creek Water Quality

Measurements of selected water quality parameters were made in the outfall from Bradshaw Reservoir as well as at three locations in East Branch Perkiomen Creek twice in April and five times per month from May to through October (Figure 4.10-1). Both *E. coli* and fecal coliform numbers were much higher in the East Branch upstream of the Bradshaw Reservoir outfall, compared to downstream, on all but two sample dates (Table 4.10-1). Similarly, the highest mean and maximum *E. coli* and fecal coliform counts for the sample period were recorded upstream of the outfall. DO levels were similar upstream and downstream of the Bradshaw Reservoir outfall in 2006. These results suggest that the reduced minimum flows from Bradshaw outfall into the East Branch Perkiomen Creek are not having an effect on bacteria levels within the stream. Overall, the general patterns of bacteria and DO concentrations observed among these stations in 2006 are similar to those observed during 2003 through 2005 sampling.

Monthly water quality measurements made in Perkiomen Creek upstream and downstream of the East Branch Perkiomen Creek (EBPC) confluence generally indicated small differences in the measured parameters between these locations (Figure 4.10-2, Table 4.10-2). On two dates bacterial concentrations were noticeably different between the stations. On August 10, bacterial levels were twice as high upstream of the EBPC confluence and are a result of activities that are outside the affected area of and unrelated to the Demonstration project. On October 12, bacterial levels were twice as high downstream of the confluence. This sampling event was coincident with a rainfall event within the lower EBPC watershed (indicated by a doubling of stream discharge from 10/11/06 to 10/12/06 at the Schwenksville gaging station on the lower EBPC), which most likely led to the increased bacterial levels downstream in the Perkiomen Creek. Overall, mean and maximum *E. coli* and fecal coliforms concentrations were lower in 2006 than during the previous years (Table 4.10-2). Measures of DO and temperature during 2006 are similar to those observed previously.

Flows from Bradshaw Reservoir were approximately 10 CFS for most of the Demonstration period (Figure 4.10-2). The flows in the upper East Branch Perkiomen Creek as monitored by the USGS Dublin gage closely reflect the discharge rate from Bradshaw Reservoir except during precipitation events. We did not observe any effects due to flow reduction, and we received no comments of concern from the public or stakeholders.

Sampling for fish and benthic macroinvertebrates was performed in the spring and late fall at four locations distributed throughout the East Branch in 2006. This work is a continuation of a sampling program that has been in place for many years to monitor the aquatic community subsequent to water releases from Bradshaw Reservoir. The results of this monitoring effort will be reported separately at a later date since the sampling results are not available for inclusion in this report.

5.0 **CONCLUSIONS**

The 2006 Demonstration was the fourth very successful year. The data continued to show that the Demonstration project provides significant benefit to the Delaware basin during all flow conditions. The data and analysis presented in this report indicate continued positive impacts from headwater augmentation (Wadesville and Still Creek), no detrimental effects from continued management of diversion system flows, and no measurable effects from consumptive water use by LGS. Additionally, we have not yet seen the added contributions to water quality from projects funded by the Restoration and Monitoring Fund. Because of the high river flows in 2006, Exelon's contribution to the Restoration and Monitoring Fund was much increased over 2005 and will soon be available to improve the future water quality of the Schuylkill River. These funds have been provided to the Schuylkill River Heritage Area to support water quality improvement projects in the Schuylkill River basin.

Suspension of the temperature restriction on withdrawal of the full amount (up to 42 MGD) of consumptive makeup water required by LGS did not affect DO levels in the lower Schuylkill River. DO levels were not correlated to flow reductions related to water withdrawal by LGS and DO levels met the Water Quality Criteria.

The minimum flow releases to East Branch Perkiomen Creek maintained stream flow in the East Branch and enhanced the flow in the Perkiomen Creek downstream of LGS's Graterford intake. There were no adverse impacts to water quality as a result of the reduced releases from Bradshaw Reservoir. No stakeholder concerns were received regarding lower flows in the East Branch.

Based on the 4 years of the Demonstration the data supports:

- Permanent approval of augmentation from Wadesville,
- Permanent approval of augmentation from Still Creek,
- Permanent removal of the 59°F temperature limit, and
- Removal of the 4-day travel time provision for augmented water flows.

The Demonstration continues to be very successful with no significant issues noted to date that would preclude moving to a long term adoption of the revised Docket criteria. Indeed there are significant water quality improvement projects underway with more to follow in the Schuylkill River Basin because of the Restoration & Monitoring Fund monies generated from this Demonstration.

We believe the data and analysis shows that the Demonstration approved by Docket Revision 12 is beneficial to the Delaware River basin and should be made permanent based on all current data. Assuming our findings in 2007 codify the previously results, Exelon will request the DRBC approve a permanent Docket Revision.